

OBSERVATIONS ON THE TRIFID TAILS IN TWO SPECIMENS OF
HEMIDACTYLUS FLAVIVIRIDIS, RÜPPEL, WITH A NOTE¹
 ON THE ARTIFICIAL REGENERATION OF DOUBLE AND TRIPLE
 TAILS OF THE "TOKHAK" LIZARD, *GECKO*
VERTICILLATUS, LAURENTI.

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(With 1 plate and a text-figure.)

INTRODUCTION.

Two specimens of ordinary house-lizards (Geckos), each with a trifid tail, were caught—one from the students' quarter, 35, Ballygunge Circular Road, Ballygunge, Calcutta, by the author himself and the other from the Professors' quarters situated within the compound of the same premises by Master Ajit Kumar Sarkar. The chief interest lies in the fact that under ordinary circumstances, the regenerated tail in Geckos is generally a straight continuation (without any sign of segmentation on the surface, except for certain differences in scaling) of the portion of the original tail left intact, whereas in the present case each specimen bears two lateral accessory regenerated branches in addition to the median regenerated tail. From a careful study of the detailed structure it was found that these two lateral branches of the tail differed markedly from the median one, and also from the double and the triple tails which were produced artificially in the laboratory by injuring either certain portions of the vertebral column of the normal tail or the cartilaginous tube of the regenerated tail of *Gecko verticillatus*.

Regeneration of tails in Geckos is not an uncommon feature, and has been referred to by several authors, and the literature dealing with allied or nearly related cases has been cited in the present communication.

GENERAL DESCRIPTION.

The description of the two specimens of *Hemidactylus flaviviridis*, Rüppel, each possessing a trifid tail, is as follows :

I. External Characters—Specimen A (Figs. 1 and 2).

(a) Measurements :

- (i) Length from snout to the vent.....8.6 cms.
- (ii) Greatest breadth across the abdomen.....1.95 cms.
- (iii) Length of the head.....2.35 cms.
- (iv) Breadth of the head.....1.63 cms.

The portion of the original tail left intact (Figs. 1 and 2; S_1 – S_5), measured 2.3 cms. from the vent. This piece of the original tail, as seen externally, is composed of five segments (S_1 – S_5), each segment being marked by the presence of four large conical scales except the basal segment (B.S.T. or S_1), where such scales are not represented. Two of these large scales are lateral in position, and are much more prominent than the two mid-dorsal ones. The whole of the regenerated tail (Med. br.) measures 4.35 cms. in length from its origin up to its tip. At a distance of nearly 9 mm. from base of the regenerated tail there arise two small accessory lateral branches apparently from the dorso-lateral walls of the regenerated tail itself. The latter is thus continued as the median tail (Med. br.), though there is a slight indication of a groove on

¹ Cf. Proceedings of the Indian Science Congress held at Nagpur in 1931.

either side, both along the dorsal and the ventral sides, just behind the origin of the two small lateral branches. The grooves run from the lateral sides, converging towards the antero-mesial direction. The right lateral branch (R.L.b) measures 4.5 mm. in length, whereas the left one measures 3.5 mm. The median branches of the tail (Med. br.) measures 3.45 cms. in length from

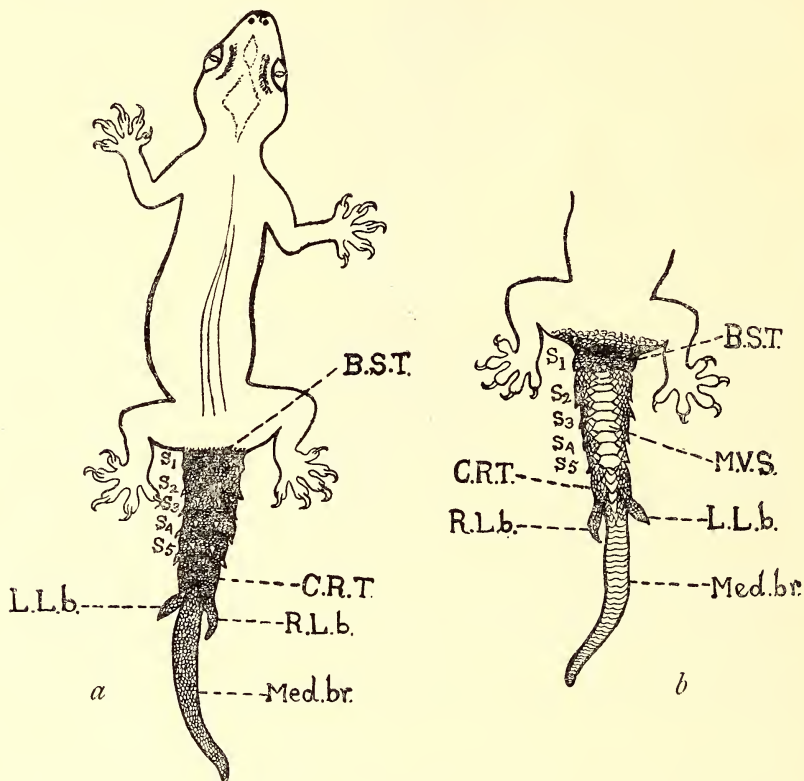


FIG. 1. Diagrammatic sketch of *Hemidactylus flaviviridis*, Rüppel, with a trifid tail; Specimen A. a. Dorsal surface; b. ventral aspect of the tail region

behind the origin of the lateral tails. The diameter of the common trunk of the regenerated tail, i.e. of the common basal stump (C.R.T.), supporting the lateral accessory as well as the median tails, immediately in front of the two lateral branches, is about 7 mms., whereas the diameter of the base of the median branch lying just behind them is about 4.5 mm.

(b) Scaling:

As regards scaling there is a very marked difference between the original portion (i.e. part of the normal tail left intact) and the regenerated portion of the tail. In the former case the scaling on the dorsal surface is more regular, and each segment as seen externally has four large conical scales as referred to above, which are absent from the regenerated tail. The general covering of scales (dorsal and lateral) over the region of the tail in front of the origin of the two lateral accessory branches, i.e., both over the normal portion of the tail as well as over the common regenerated trunk, are small and very nearly of the same pattern, while those over the three regenerated branches (i.e., the two lateral branches and the median one) are slightly larger and dissimilar, and are arranged irregularly. The mid-ventral row of large laterally elongated

scales (fig. 2 *b*; M.V.S.) prominently seen on the original tail, also extends over the common regenerated trunk as well as over the median branch of the regenerated portion of the tail, but here they are strikingly different in form and shape; and the lateral branches, viz., the accessory tails, are devoid of such large scales; in other words, the latter are covered over by small scales only which are of the same pattern both on the dorsal and the ventral sides.

(c) Colouration:

As to the colouration, the three regenerated branches are slightly more greyish in appearance than the rest of the tail.

SPECIMEN B. (Pl. 1)

(a) Measurements:

- (i) Length from snout to the vent.....8.1 cms.
- (ii) Greatest breadth across the abdomen.....1.95 cms.
- (iii) Length of the head.....2.1 cms.
- (iv) Breadth of the head.....1.65 cms.

The portion of the original tail (Pl. 1, S_1 - S_2) left intact measured 7.5 mm. This portion of the original tail is really composed of two segments, and, as seen externally, it is marked by a definite groove which separates the basal segment (B.S.T. or S_1) from the posterior one (S_2)—both of these having no conical scales: the absence of such scales from the posterior segment is an uncommon feature, and is probably due to destruction caused by certain injuries over the area bearing these scales. Out of the three branches of the regenerated tail, the median branch (Med. br.) is larger than the two lateral ones and measures 2.45 cms., whereas the right lateral branch (R.L.b.) measures 1.75 cms., and the left one (L.L.b.) 1.7 cms. The two lateral accessory branches are comparatively larger than those of the specimen A, but the median regenerated tail is relatively smaller. The three branches of the regenerated tail arise directly from the very end of the original tail left intact, and not from a common regenerated trunk as in specimen A described above. A posterior groove on either side is very well-marked (especially on the dorsal side), and runs from just behind the base of each lateral tail towards the antero-mesial direction as seen in specimen A, but the line of demarcation between the original portion of the tail and the regenerated portion is very clearly marked in this particular specimen (not so well differentiated in the former case), and runs postero-mesially from the lateral sides to meet at a common point at which the two posterior grooves (just mentioned) also unite. The diameter of the common base (from which are given off the three branches) of the regenerated tail is 1.2 cms., whereas the base of the median branch, i.e. of the region lying immediately behind the origin of the two lateral accessory branches, measures .4 cm. across its diameter.

(b) Scaling:

The dorsal scaling of the three regenerated branches differs from that of the original tail in being irregular and larger in size, but the mid-ventral row of laterally elongated scales are present on all the three branches, and are of the same pattern. In this respect, viz., in the possession of the mid-ventral row of scales on all the three regenerated branches of the tail, specimen B differs very strikingly from specimen A.

It is a noteworthy fact that the scales of the regenerated (renewed) tail, or of the accessory tails differ from those of the original (normal) tail in those reptiles, which have the power of reproducing their tail, but according to Boulenger (3) this view is erroneous, and "in some cases, the aberrant scaling of the reproduced tail is a reversion to an ancestral form."

(c) Colouration:

The colouration of the regenerated tail is pretty nearly the same as in specimen A.

HISTOLOGY.

Specimen A.

In the regenerated tail, as we know, a cartilaginous tube extends from the very end of the portion of the original tail left intact, in continuation with the last vertebra (i.e. the portion actually left over), up to the end of the regenerated tail. By section-cutting it is found that the two lateral accessory branches

bear no such cartilaginous tube as that seen in the median regenerated portion in which it is continued straight backwards from its base. There is a fairly well-developed groove encircling the cartilaginous tube, i.e., there is a distinct constriction at the point from where the two lateral tails are given off. Serial frontal sections also show that the cartilage cells at the constriction are comparatively much larger than those of the other parts, and are in a state of proliferation, and they push their way inwards towards the central canal lodging the spinal cord. There is also a connective tissue investment encircling the tube, but this is interrupted at the constriction.

The histological condition of the central cartilaginous tube, viz., the presence of a very distinct constriction as well as discontinuity of the connective tissue sheath in the constricted area, suggests that probably the anterior portion of the regenerated tail, i.e., the basal stumpy portion (Figs. 1 and 2; C.R.T.) is *primarily* regenerated from the sides of which are developed the two accessory fleshy lobes (R.L.b. and L.L.b.), whereas the median part (Med. br.) of the tail is *secondarily* regenerated—the fleshy lobes being probably formed after the median part has sufficiently developed due to certain injuries being received over the common regenerated trunk near the junction of the two portions of the regenerated tail.

The cartilaginous tube is devoid of any segmentation and perforation. It tapers with the tail, and its lumen ends blindly at the tip.

Neural and hæmal arches are wholly wanting in the area of regeneration.

Inside the lumen of the cartilaginous tube the following structures are present :—

(a) The tapering part of the spinal cord in continuation with the cellular lining of the *canalis centralis*, and practically having very few external nerve fibres.

(b) A network of blood-vessels—the capillaries being irregularly disposed here and there.

(c) A very few pigment cells are also scattered about.

(d) The fatty layer is extremely thick, and consequently the musculature is thin within the median regenerated tail, but the two lateral accessory branches are mainly muscular outgrowths with a limited number of adipose cells.

Specimen B :

As in specimen A the cartilaginous tube is one continuous piece, and forms the central axis of the median regenerated tail only. The lateral branches are devoid of any such structure ; that is to say, these are merely fleshy outgrowths, without any hard supporting structure inside them. Further, in the absence of any groove or constriction towards the anterior part of the cartilaginous tube and in the presence of a continuous sheath of connective tissue, it is so very characteristically different from the previous case already described.

It appears that in this case *the whole of the newly added tail is primarily regenerated*, and owing to injuries having been received towards its anterior end, two fleshy lobes (Pl. 1 ; R.L.b. and L.L.b.) have thus developed later in life. But the injuries in this specimen had possibly also affected the mid-ventral row of scales of the regenerated tail, which probably thus led to the extension of these scales over the ventral sides of the lateral branches as well, whilst it might be remarked that in specimen A the injuries had not gone far enough to affect the mid-ventral row of scales, and consequently, the latter was absent from the accessory lateral tails of that specimen.

GENERAL REMARKS.

To be brief, it may be said that the regeneration or the production of double or triple tails in lizards (1, 2, 4, 5, 6) is by no means an uncommon phenomenon under natural conditions. That might be due to certain accidents, either to partial injuries to the muscular coat only, or to deeper injuries affecting the muscular layers as well as one or more vertebræ of the original tail.

Tornier (7) has been able to produce experimentally double and triple tails in the case of *Lacerta agilis* with cartilaginous tubes forming the central axes or supporting structures for the lateral outgrowths.

Woodland (8) has succeeded in producing an extra tail without any cartilaginous tube entering into it in each of the four examples of *Hemidactylus*

flaviviridis, Rüppel. This accessory tail is, therefore, simply a muscular outgrowth from the side of the original tail, or from that of the regenerated tail.

From a series of well-graded experiments conducted on the caudal autotomy of a less common lizard, *Gecko verticillatus* (pl. 3) in the laboratory by injuring the tails in various ways, I have observed in nearly all cases (out of many double and triple tails having been produced), that a lateral outgrowth or accessory tail is produced from the normal, or from the regenerated tail without any supporting skeletal structure when the injury is not sufficiently deep, i.e., when it affects the muscular coat only. In such cases, the accessory regenerated tails are merely elongated fleshy lobes, but if the wound is sufficiently deep, and has affected either the vertebral column of the original tail, or the central cartilaginous tube of the regenerated tail, then in all such cases, an accessory cartilaginous tube¹ is also developed from the point of injury, and extends as a supporting structure inside the accessory regenerated tail.

From the experimental results on the regeneration of tails in certain Lacertilians obtained by Tornier (7), Woodland (8), myself and others, it clearly follows that an accessory tail without a cartilaginous tube may not be an unusual feature, and that in order to produce an accessory tail with a central cartilaginous tube, the injury must be deep enough to reach the vertebral column of the original tail, or the central cartilaginous tube of the regenerated tail.

The three-tailed condition (or the trifid tails) of the two specimens of *Hemidactylus flaviviridis*, each possessing, i.e., two accessory fleshy lobes without any supporting skeleton, together with the median regenerated tail bearing a central cartilaginous axis, is undoubtedly the outcome of injuries apparently received twice due to certain unknown causes, firstly, to the deeper parts of the original tail, affecting its vertebral column and severing it completely, and thus producing a median regenerated tail, and, secondly, to the muscular part of the regenerated tail thus produced on its both sides: under the latter circumstances two accessory muscular lobes have developed.

Here I wish to express my indebtedness to Professor B. K. Das, D. Sc., for his constant guidance, invaluable suggestions and kind criticisms. My thanks are also due to Master Ajit Kumar Sarkar for the gift of the specimen.

EXPLANATION OF PLATE.

- Fig. 1. Photograph of the dorsal view of *Hemidactylus flaviviridis*, Rüppel, with a trifid tail. Specimen B.
 ,, 2. Photograph of the dorsal view of *Gecko verticillatus*, Laurenti, with a triple tail produced artificially.

LIST OF ABBREVIATIONS USED.

B. S. T.	... Unsegmented base of the original tail.
C. R. T.	... Common regenerated trunk.
L. L. b.	... Left lateral branch or accessory lateral tail.
Med. br.	... Median branch of the trifid tail.
M. V. S.	... Mid-ventral row of scales.
R. L. b.	... Right lateral branch or accessory lateral tail.
S ₁ -S ₅ Segments of the portion of the original tail left intact.

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¹ Tornier (7) has shown that more than one cartilaginous tube may also extend inside a single accessory tail, if two or more neighbouring vertebrae be injured,

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